N94-15567

# An improved light source for laser ranging

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## Summary

The development of a new laser material, Cr-doped LiSAF makes possible the development of a laser source for satellite ranging systems that is superior in performance capabilities than current Nd:YAG-based laser sources. This new material offers the potential of shorter pulses and more preferrable wavelengths (850nm and 425nm) than multi-wavelength Nd:YAG systems, leading to superior ranging resolution and greater detection sensitivity.

We are embarking on a feasibility study of a two-wavelength , mode-locked laser system based on Cr:LiSAF, providing shorter pulses for improved ranging resolution.

## Background

Current satellite multi-wavelength laser-ranging systems operating with Nd:YAG based systems are capable of resolving earth-satellite distances to within a centimeter. The latter limitation is primary set by the minimum pulse-duration available from current field-usable mode-locked Nd:YAG laser systems having diffraction-limited beam divergence. Recent developments in ultrashort laser pulse technology with a new laser material perfected at CREOL in the last two years, now offers the possibility of an improved multi-wavelength laser-ranging system. The principal advantages this new material will offer is in shorter laser pulse durations, down to a few picoseconds, thereby improving ranging accuracy to the millimeter level, and in the use of shorter laser wavelengths permitting detection in a region of higher photocathode sensitivity, thereby improving overall sensitivity.

The new laser material Cr-doped LiSAF[1] has already been extensively studied[2,3], and reliable mode-locked operation has been demonstrated[4]. At the present time most of the technology of Cr-doped LiSAF is resident at CREOL. This has occured as consequence of it's crystal growth development at CREOL, and in a concerted effort being made by CREOL scientists to determine it's optical and physical properties. As a consequence, many laboratories are examining potential applications of this exciting new laser material.

## Technical Details

We wish to take advantage of the possibilities offered by Cr:LiSAF in developing a fieldable laser for satellite ranging providing the general properties referred to above. A modelocked Cr:LiSAF laser can be built under this program that would have the principal components shown in fig.1.

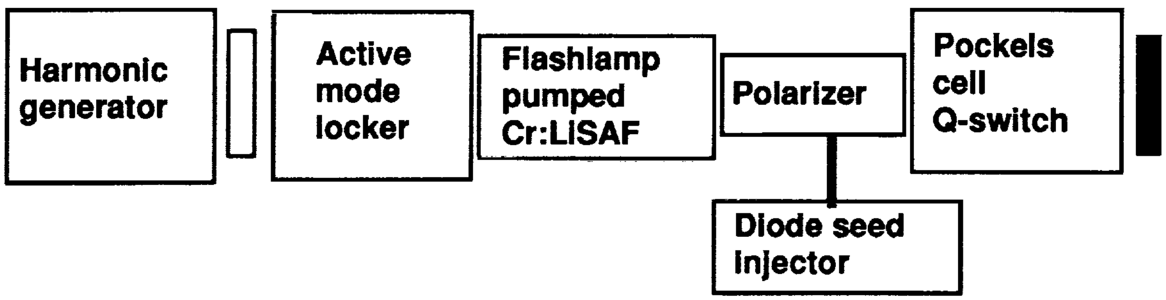


Fig.1. Schematic of an actively modelocked multifrequency Cr:LiSAF laser for satellite ranging

A cw single mode diode laser operating at ~845nm can be used to seed the Cr:LiSAF laser with a specific frequency. This will both control the frequency of the laser, and it's harmonic, and ensure that the modelocked laser has single mode output itself, ensuring diffraction-limited beam divergence. Short pulses wouldbe formed within the laser with the aid of conventional modelocking and Q-switching techniques. With the laser locked to a specific output frequency, efficient, stable, phase-matched second harmonic conversion will be guaranteed. The output performance of the laser will have the following parameters

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|---|---|---|---|
| Energy per pulse-train | 500mJ | Wavelength | 850nm |
| Number of pulses | 10 | Energy per pulse | 50mJ |
| Pulse-duration | 30ps | Pulse separation | 10ns |
| Second Harmonic Conv. Eff. | 25% | En. @ 425nm | 12.5mJ |

## References


1. S.A. Payne, L.L. Chase, L.K. Smith, W.L. Kway, and H.W. Newkirk, "Laser performance of $LiSrAlF_6:Cr^{3+}$," J. Appl. Phys. **66**, 1051, 1989.
2. P. Beaud, Y-F. Chen, B. Chai, and M. Richardson, "Small-signal gain properties of $LiSrAlF_6:Cr^{3+}$", submitted to Optics Letters.
3. Y. F. Chen, P. Beaud, B. H. T. Chai & M. Richardson, "Small signal gain measurements of Cr-doped LiSAF and LiCAF" Proc. Conf. on Advanced Solid State Lasers Santa Fe (Optical Society of America 1992) to be published.
4. P. Beaud, E. Miesak, Y-F. Chen, B. H. T. Chen and M. Richardson, "A flashlamp-pumped Cr:LiSAF regenerative amplifier" Proc . Conf. on Advanced Solid State Lasers Santa Fe (Optical Society of America 1992) to be published.

# Epoch and Event Timing